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PHYSIOLOGY
OF THE
HUMAN VOICE

F. ROMER.

45. 874.

THE

PHYSIOLOGY

OF

THE HUMAN VOICE;

BEING
A TREATISE ON THE NATURAL POWERS OF THE VOCAL ORGAN,
POINTING OUT
THE DIFFERENCE BETWEEN THE SPEAKING AND SINGING
QUALITY OF TONE, AND GIVING LAWS FOR THE
PROPER PRODUCTION OF THE MUSICAL
VOICE, FROM ITS LOWEST TO
ITS HIGHEST PITCH.

BY F. ROMER.

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PREFACE.

In bringing before the public the following exposition of certain discoveries I have made respecting the manner and means by which nature produces the different tones in the human voice, it has been my endeavour to simplify and condense the work as far as the subject would in any way permit; nevertheless, I have no doubt that, to the general reader, it will at first appear complicated; since, in treating physiologically of the human voice, a writer is forced to use the technicalities of three distinct sciences, namely, Anatomy, Acoustics, and Music. To explain these, I have annexed a glossary of the different technical terms that occur in the course of my work; and the explanations contained in that glossary I have endeavoured to give in as few words as their various meanings would possibly allow.

I must also caution even the experienced singer against forming conclusions, respecting the theories submitted in this treatise, before giving to the voice that careful and minute

investigation regarding its quality of tone which it necessarily requires. For what I have advanced, has been tested by many years' constant and practical study of the vocal organ, and may be proved by every person, after devoting to the subject that attention and consideration which it demands.

The first chapter, in the following paper, being in opposition to the received notion, that the glottis is the sole point producing the vibrations of the human voice, has been inserted in the medical journal, the "Lancet," for December 28, 1844; for I thought it a right course to lay that part before the medical profession previous to publishing the entire work.

The great change that must take place in the system of vocal tuition, if it can be proved that the larynx and glottis are not the points which produce the musical tones of the voice, will be perfectly obvious to those who have physiologically studied the subject.

11, *Harrington Street,*
Hampstead Road.

CONTENTS.

CHAP. I.

On the vocal instrument having two distinct points for producing its vibrations; one for forming its *speaking*, and the other its *musical* quality of tone—the speaking voice depending on modifications and contractions of the larynx and glottis, the musical voice being a vibrated column of air, depending upon the openness of the tube..... 1

CHAP. II.

On the basis of the human voice, being a certain number of fundamental notes, formed by a double vibrated column of air, depending upon the length of the trachea for their pitch; and each fundamental note having a scale, or succession of notes, leading up to its sharp seventh, produced by alterations in the vibrating column, and governed by the free action of the diaphragm.... 17

CHAP. III.

On the human voice producing harmonics, in the same manner as all musical wind instruments, which harmonics are dependant on the fundamental notes for their pitch, and have, according to their degree, scales, or a succession of notes ascending; which scales are governed by the free action of the diaphragm..... 30

CHAP. IV.

That there is no fixed break or sudden change in the quality or power of the voice, while moving it from its lowest to its highest tones; and that what are commonly known as breaks arise from the contraction of the larynx and glottis, which contraction takes from the diaphragm its free action, and so prevents the necessary changes in the column of air which are requisite for the production of the different notes or scales; also, that the tones of the voice are dependant on the action of the nervous system..... 43

CHAP. V.

Concerning the manner of applying the foregoing theories in vocal tuition, and briefly explaining the laws, and mode of producing and cultivating the tones of the musical voice..... 51

Glossary..... 66

PHYSIOLOGY OF THE HUMAN VOICE.

CHAP. I.

On the vocal instrument having two distinct points for producing its vibrations; one for forming its *speaking*, and the other its *musical* quality of tone,—the speaking voice depending on modifications and contractions of the larynx and glottis, the musical voice being a vibrated column of air, depending upon the openness of the tube.

THE various theories and the difference of opinion, existing both in England and on the Continent, regarding the means by which nature produces the different qualities of tone in the human voice, forced me (in the first instance) to study very minutely, for my own satisfaction and guidance, as a professor of music, the manner in which different pupils of opposite temperaments produced the various sounds which are within the powers and compass of the vocal organ.

Physicians generally have considered the tones of the voice to be caused by the vibra-

tion of certain elastic and solid bodies, seated in the upper part of the throat.

Musical men differ very widely in their opinions on the subject; but most of them have laid it down as a law (even to M. Manuel Garcia, in his last work presented to, and adopted by, the Academy of Science at Paris, 12th of April, 1841), that the voice is produced and governed by the movement of the glottis, and the rising and falling of the larynx. It is due, however, to M. Garcia to state, that he proves the fixedness of the larynx in what he calls the sombre quality of the voice, but states decidedly that the larynx must ascend, in the production of what he calls the clear quality of the chest voice. At the present moment, in Italy, most of the professors of singing concur in opinion, that the upper notes of the voice are dependant upon the proper production of the lower tones.

My object in this treatise is to prove, *firstly*, that the human voice has two distinct points of production, and that all proper musical sounds are formed in the lower tube (the trachea); *secondly*, that the musical

tones of the voice are divided into two qualities, the same as in all musical wind instruments, namely, double vibrated notes, and single vibrated notes, or harmonics, governed by the laws laid down in acoustics; *thirdly*, that there is no sudden or fixed break in the voice when produced according to nature; and *fourthly*, that, in the use of the musical voice, no contraction whatever should take place in the tube by moving the larynx or glottis, all such movements tending to harden or weaken the purity of the tone.

1st. Of the Production of Musical Sounds being in the Trachea.

The evidence I am about to offer, in regard to the lower part of the trachea being the point of production of true musical sounds, is completely separate from the various facts I shall bring forward, while considering the vocal organ in its different qualities of tone; but, knowing the number of works (by learned and clever men) that have been written upon the physiology of the human voice, and that they all agree that the larynx is the point of production, I feel that it is better to enter on that question

at first, and give simply the practical observations I have made during a long and continued study of the subject.

In considering the vocal instrument, all will allow that it is a tube with certain powers of contracting at different points; the first point is at the inferior or lower part of the trachea*; the second point is at the glottis; and the third point, the mouth; it has various other powers of contracting or closing itself, such as the epiglottis, the uvula, the pharynx, &c. But these contractions produce very harsh and uneven

* Valentin has succeeded in producing distinct contractions of the rings of the trachea, by irritating the par vagum in the rabbit; and he thinks a similar action might be induced in the bronchi and their ramifications. From the experiments of Dr. C. B. Williams, it appears that the air tubes are endowed with a considerable amount of irritability, and may be excited by electrical, chemical, or mechanical stimuli applied to themselves. It is chiefly manifested in the smaller bronchial tubes; since, in the trachea and the larger bronchi, the cartilaginous rings prevent any decided diminution in the calibre of the tube. Wedemeyer also states, that the tubes of less than a line in diameter could be perceived to contract gradually under the stimulus of galvanism, until their cavity was nearly obliterated. The opinions of Reissisen on this point are also well known.

kinds of sound, and are seldom resorted to (even by the worst singers); therefore, I shall not include the contractions of these organs in the points by which sounds may be produced for useful purposes. From the *first point* (the lower part of the trachea), I am about to prove, spring vibrations, which, on being reflected by the whole length of the tube, produce *perfect musical sounds.* From the *second point* (the glottis), sounds more useful, but certainly *not* at all musical, are produced; namely, the *speaking voice.* The third point (the mouth), from its having no length of tube to reflect its vibrations, produces, by compressing the lips, a thin shrill quality of sound, called *whistling.*

Now, if a musical note be produced at the third point (the mouth), it must be allowed that no sound whatever can be formed at the same time by the other points, the contraction of the lips cutting off all power of sustaining vibrations in the *vocal tube;* and upon the same principle, when the point of production is at the glottis, the vibrations in the lower tube cannot be sustained; but, when the first point is used, the

whole tube is felt to be in a state of sonorous vibration, and a perfect musical sound is produced. This can easily be tested by the stethoscope. But it must be kept in mind, that the fact of any particular portion of the tube being felt to be in a sonorous state of vibration, is no proof of that part being the point of production; because the powerful and fixed compression of the point producing the first vibrations, prevents its having that elastic and vibrating quality it otherwise would have. Consequently the point of production must be below any portion of the tube felt to be in a sonorous state of vibration; as, on the same principle, the sounding-board of a musical instrument is not the point of production of the sound.

On examining the vocal tube, it will be found to correspond in formation to most musical wind instruments; it has the power to elongate or shorten itself by means of the trachea. It also corresponds with wind instruments in general, in the fact that its fundamental notes depend upon the length of its tube, as with the trumpet, French horn, flute, clarinet, &c.; but it differs from all

other wind instruments, in its power to contract itself at the different points that I have before mentioned. The functions of the second point (the glottis), and its nervous tendency to contract, are well known; that the whole of the parts forming the tube are elastic bodies, and that it is their nature to vibrate in the highest degree, are facts equally indisputable. So, when a musical note is produced at the first point, the whole of the tube, including the larynx, pharynx, and the different portions of the mouth, &c. become reflectors of the vibrations, or, in other words, the sounding-board of the vocal instrument.

That the second point (the glottis and larynx) is the production of the speaking voice while conversing, there is no doubt. When, however, we become excited, and wish to portray deep feeling with passion and energy, we instantly change the point of production, and use the fundamental tones of the musical voice; but when the sentiment we wish to express is calmer, yet equally intense in its feeling, we use the harmonics of the musical quality. In fact, the moment per-

sons speak, we can intuitively tell whether they are actuated by true feeling or not, by the quality or tone of the voice they use. The lighter or more frivolous the subject of our discourse, the more we contract the glottis; but if this contraction of the glottis be carried to too great an extent, the voice becomes affected and unpleasant; every one feeling that it is against nature, and that the speaker is using art, with forced and unnatural formations of the throat, instead of simplicity and freedom in the production of the tones.

One of the most striking instances of this power of changing the qualities of the voice, that I can remember, was the late Edmund Kean, the celebrated actor; he possessed the knowledge and ability to use them at will; his voice, when produced from the second point (the glottis), was harsh and unmusical in the extreme; but when he wished to picture passionate feeling with energy, he instantly changed to the musical fundamental tone; and, in the softer passages, he used the harmonics with openness and purity. It was this that gave rise to the various

opinions as regards the quality of his voice; some persons insisting that it was musical and beautiful, and others, that it was harsh and unpleasant.

To gain power over these different qualities of the voice, should be the great study of all public speakers; for, there is no doubt that *it is tone alone that expresses the intensity of our feelings—language conveying our ideas, and emphasis giving force to our language.* I have known instances of persons using the harmonics of the musical voice, when speaking, without having recourse to the fundamental tones; consequently, although their musical abilities had been ever so great, and their conceptions perfect, they could not have portrayed deep and energetic passions, from not having cultivated the fundamental quality of their musical voice, while, from the want of proper exercise, it had become weak, and they had lost the power of using it. Were singers to practise upon this principle, their intonation would never be perfect, from a deficiency in the foundation or fundamental quality of voice.

These different productions of the speak-

ing voice may be felt, and proved, by the stethoscope. The action of the larynx can be plainly seen during the time of common parlance; for, in using the second point of production, it is forced into constant motion, having to shift its position for each inflection or slight alteration of the tone; but when the voice changes to its musical quality (its first point of production), the larynx takes its lowest position, which is a strong proof that the glottis is perfectly open, and never moves for the different inflections of tone, *if produced with purity and freedom.* The larynx will be moved slightly by the action of the tongue, &c. in forming close vowels or contracted consonants, but it will instantly regain its original position.

If we apply the stethoscope, when a very powerful note is produced by contracting the glottis, a slight vibration may be felt below the point of production; but this will be found to be only a reflected vibration, not one springing from the lower tube, the trachea.

The chief argument used by all modern physiologists against this theory, and which

seems to have stopped all further research upon the subject, is rested on certain results which arose from the experiment of opening the tube above and below the larynx*. When the trachea is opened below the larynx, the voice and speech during the time of such opening no longer exist; but when the incision is above the larynx, the voice is preserved. Now, as regards all those sounds formed by the glottis (the second point), there can be no doubt that they would be entirely lost, if an opening were made below their point of production; but this fact does not in any way prove the inefficiency

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* Galen was of opinion that the principal organ of the voice was the glottis; *but still he allowed that the trachea had a considerable share in the production of the sound.* This theory was acted upon by the ancients and moderns until the time of M. Dodart, who stated, that, for the trachea to effect the resonance, as was the common opinion, it would be required that the air, after it had been modified and turned into sound by the glottis, instead of continuing its course from within outwards, should return from without inwards, and thus strike upon the sides of the trachea. This, we are well aware, it does not; but M. Dodart has not allowed for the power of the bronchial tubes to produce vibrations by muscular contraction, *and which power is a proof that they are a point of production of sound.*

of the trachea in the production of the musical quality of tone; because, *firstly*, when an opening has been made in the human trachea, we have had no proof that the patient operated upon had the knowledge and power requisite for the proper production of the musical voice; *secondly*, it must be allowed, that even though the patient possessed the knowledge of using the musical voice, still the powers of the instrument, by shortening the tube to so great an extent, must be entirely changed, in consequence of the vibrating qualities and resonance of the whole of the upper part of the tube being checked or stopped; *thirdly*, if such an opening in the trachea were to act upon the contracting muscles of the larynx, it would be impossible to produce the musical quality of voice, from the want of a proper vent for its vibrations; and this was most probably the case; for I shall be able to prove, that to guard againt the nervous contraction of the glottis, &c. it requires the greatest care and attention (even when the tube is in a healthy state); *fourthly*, it is possible that an incision in the trachea may affect the bron-

chial tubes, so as to prevent them producing vibrations; for it is known, that under great excitement we often lose the power of using the musical voice; *fifthly*, when an opening is made above the larynx, the speaking voice can be used, because its tones are produced by contraction; but it is perfectly natural to suppose, that the slightest disorganization of any portion of the tube would take away all power over the musical quality of the voice, it being of a more refined character, and depending to a very great extent upon our feelings for the production of its tone; consequently, should an incision *above or below the larynx cause contraction of the glottis, the musical voice must be lost;* though the speaking voice, being produced *by contraction* of the glottis, could be used, except when an opening were made below its point of production.

In conclusion of this portion of my subject, I beg to remark, that it is my opinion that the first vibrations of the musical voice are produced by the smaller bronchial tubes; the vibrations of which, upon being thrown into one large column, produce the different

fundamental notes (dependant on the length of the tube) from which spring the different harmonics, &c. while, from the fact of there being no hard or fixed compression at the point producing the first vibrations, we can account for the beauty and purity of tone of the human musical voice, over all other wind instruments. Thus the vocal organ may be likened to an infinite number of minute wind instruments formed into one tube, the vibrations of which gain power from the resonance given to them by the larynx, pharynx, palatine arches, &c. The shortness of the tube, to produce the lower notes of the voice by simple vibrations, is fully accounted for by M. Savart*.

Various experiments, of the most elaborate character, have been tried upon a human larynx by Müller, Savart, and others; and different kinds of sound have been pro-

* M. Savart has discovered that a column of air yields tones of a much lower pitch in flexible elastic tubes, than in solid pipes of the same length. The relaxation of the walls of a flexible tube, by impregnation with the vapour of water will have the effect of lowering the pitch of its fundamental note as much as two octaves.

duced by such means; but that these sounds possessed the pure and open quality of tone belonging to the musical voice, has not been proved*. Müller affirms that the sounds formed by the glottis cannot (to any extent) be dependant for their pitch or resonance on the pipe; for the point of production having an upper and lower tube, one partially destroys the effect of the other. In fact, a tube fixed above and below a membranous tongue, has been found one of the most difficult problems in the science of acoustics, and no results have been arrived at which approximate to a law.

From these considerations, then, it results that there are two points of production which can be used in speaking or singing. The first point producing pure musical notes (depending upon the openness and freedom of the tube) by *a column of air*, whose vibrations are reflected by the powerful resonance

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* M. Savart *denies* that the quality of the tone produced by these experiments was like the human voice, stating, on the contrary, that they were *harsh and discordant in the extreme.*

of the larynx, pharynx, palatine arches, &c.*; the second point (the glottis) producing speech by the *force of vibrations excited by muscular tension and contraction alone.*

A modification of these two qualities of tone is often used, and with good effect, by slight contractions of the glottis, &c.; but, as I wish to prove the powers of the perfect musical voice, and the laws by which it is governed, I shall not enter on, or discuss, these different modifications; merely stating that while the aperture of the glottis is kept open enough to allow the vibrations produced by the first point to pass, the pitch, &c. of the various tones is governed by, and dependant on, the laws of that quality.

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* Müller says that "the approximation of the palatine arches and retraction of the uvula in the production of the higher notes, seems to be merely the result of involuntary, associate, nervous action, caused by the voluntarily increased extension of the muscles of the larynx. If the palatine arches contribute at all to the production of the higher notes of the voice and the falsetto register, it can only be by their increased tension strengthening the resonance."

CHAP. II.

On the basis of the human voice, being a certain number of fundamental notes, formed by a double vibrated column of air, depending upon the length of the trachea for their pitch; and each fundamental note having a scale, or succession of notes, leading up to its sharp seventh, produced by alterations in the vibrating column, and governed by the free action of the diaphragm.

THE fundamental notes of the voice are double vibrated tones, produced from the first point by the action of the diaphragm, the upper portion of the tube being at the same time kept free and open, by which means a node of vibration is formed. It is easy to be ascertained by the following test whether this node is produced. If produced, the whole tube will be felt to be in a state of sonorous vibration, which vibrations will have the feeling of returning, and the voice be capable of being forced into its full power by the lungs, without straining any of the membranes of the throat, but, on the contrary, keeping all parts of the tube free and relaxed: there will also be an open, sonorous quality in the sound that cannot be mistaken.

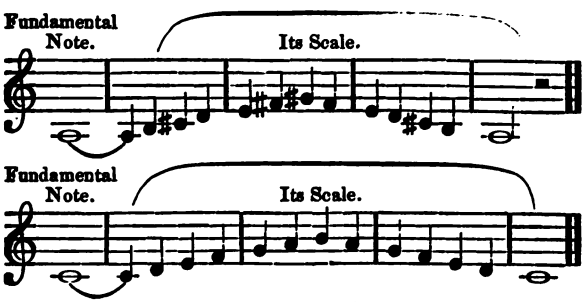
The best rules I can give for producing these notes are, first, to take the breath the same as when about to sigh; for nature then inflates the lungs to their fullest possible extent, in the most simple and easy manner. When the breath is thus taken, vibrate it freely by a very slight impetus from the lungs at the first point, being careful to keep the tube as open as possible. Should the vibrations be sonorous enough, a node will be formed. It is easy to sustain the column of air in a state of vibration, when it is once set in motion; for it must always be kept in mind that the *force of breath and the force of vibration are quite different.* If we give the slightest impetus from the lungs without creating vibrations, the breath instantly escapes, as when sighing; but it is quite the opposite when vibrations are produced; the breath *cannot* then escape freely; for the more powerful the vibrations, the less the quantity of breath that passes through the tube. This can be tested by the beats of the metronome, while holding on a note, first in the full, then in a weak or thin quality of voice.

Each fundamental note of the voice depends on the length of the lower portion of the tube *(the trachea)** ; it also has a scale leading up to its sharp seventh. This scale is governed by the laws laid down in acoustics; namely—each note, as it ascends, increases in vibrations. We can carry the quality of tone used in this scale beyond its natural limits in two ways: *firstly*, by moving the fundamental note with its scale to the highest pitch that the trachea will allow; but to do this requires great energy

* The pitch of a sound given by a reed, through its union with a tube, has been ascertained by Weber. The results are—first, the pitch of a reed may be lowered, but cannot be raised, by joining it to a tube; second, the sinking of the pitch of a reed thus produced is, at the utmost, not more than an octave; third, the fundamental note of the reed thus lowered may be raised again to its original pitch, by a further lengthening of the tube, and by a further increase again lowered; fourth, the length of the tube necessary to lower the pitch of the instrument to any given point, depends on the relation which exists between the frequency of the vibrations of the reed, and those of the column of air in the tubes, each taken separately. This satisfactorily agrees with the trachea being a portion of the vocal instrument; while the length of the tube altering the pitch of the reed, accounts for the difference of an octave between the male and female voice.

and force of vibration; and *secondly*, by changing the point of production to the glottis, &c. which never should be resorted to; for the quality of the voice then becomes guttural, or hard and unpleasant, besides bringing many other evils, which I shall point out when treating of the break in voices.

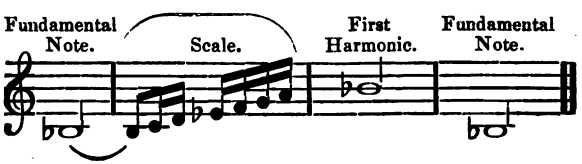
Scales of the different Fundamental Notes.



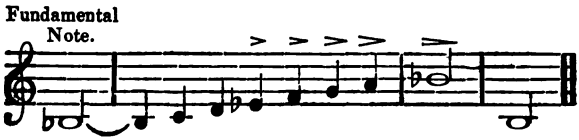
These examples are understood to be an octave lower in the man's voice.

That these fundamental notes are formed by the length of the trachea, which can be plainly felt to shorten or elongate itself when they are changed, and that the whole of a piece or passage of music in any particular key is governed by, and entirely dependant on, its fundamental note, I shall be able to prove beyond a doubt.

Suppose we take a fundamental note and sing its scale ascending, passing into its first harmonic, which is an octave higher than such fundamental note; it will then be found that, by using the same force of vibration, and without altering the glottis or tube in the slightest manner, the voice can return in an instant to its fundamental note with the greatest ease—the agency of the diaphragm alone changing the column of air from *single* into *double* vibrations: thus



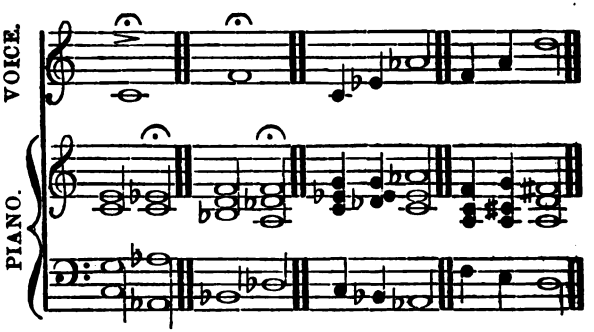
But if, by using energy and force of vibration, we carry the fundamental quality of voice *one note above its scale* (to the octave), the lower part of the trachea will be felt to ascend, according to the number of fundamental notes taken higher; and it will be found impossible, in consequence of the fundamental note having been moved, to regain the lower octave, without altering the tube and allowing the trachea to fall.



Upon singing the preceding scale, and accenting it with energy, as I have marked, the difficulty before mentioned will be felt.

We naturally make the key-note of any piece of music we sing, the fundamental note of the voice, if it be easily within the power of the trachea: whereas, if it prove too high to be sustained with freedom, we then drop the fundamental note to its dominant (below), by allowing the trachea to take a lower position. This clearly explains why singers feel so much difficulty in using their voices in certain keys, even though the notes should be, as they consider, well within the range or compass of their vocal organ; in fact, it appears to me that most singers must lose a portion of their power, brilliancy, and freedom, when singing in certain keys.

This natural tendency of the voice to fix its fundamental note on the key-note or dominant of the scale in which we sing, may be felt by singing any note in one key, and then, by changing the harmonies, moving it into another key; thus:

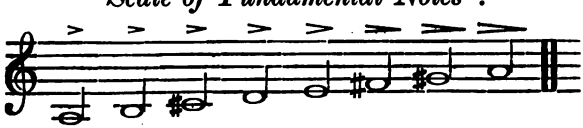


It will be found that, as soon as the chord is struck that changes the key, we have a feeling or wish to move the fundamental note, by altering the position of the trachea; for it is impossible to sing two bars properly with the fundamental note in a false key. If a singer well accustomed to these transitions try the foregoing examples, he will not have the feeling so acutely as the more unpractised student; the skilful vocalist having made it his study to move the voice under these circumstances, by changing the fundamental note.

The whole range of the fundamental notes may be used in any one key or scale, and often are so by many singers; but few (if any) have perfect command over them;

but this shifting of the fundamental notes never should be resorted to, except when the artist wsshes to portray passions requiring the greatest excitement and energy of feeling. The notes cannot be moved with the same facility as their scales; for the trachea is obliged to alter its position to form each note. This shortening of the trachea will be plainly felt while producing a succession of these fundamental notes. The larynx will be found to remain firmly fixed in its lowest position, and so aiding the trachea in diminishing its length. As these notes ascend, the greatest energy and power of vibration will be requisite to produce them. If we attempt to carry them beyond the natural powers of the trachea, either a hoarse, weak note, making the throat feel quite sore, will be the consequence, or the voice will break into one of its harmonics.

Scale of Fundamental Notes.*



* Few persons have more than five or six fundamental notes, with freedom enough to produce their scales and har-

To produce these notes, they must be accented in the manner I have marked. Their pitch and compass depend upon the formation and power of the vocal instrument. It should however be remembered, that, when we have moved the trachea to its highest fundamental note, we can sing its scale, leading up to its sharp seventh; but it requires, as I have stated before, the greatest possible command over the voice, to keep the trachea in so high a position.

Many persons who study singing have not the slightest command over these fundamental notes; in fact, they cannot produce them, never having been accustomed to the practice; and the voice, like any other faculty of the body, will fall into decay from disuse. Many young vocal students (particularly those in private life), from a fear of making false notes, or of being thought to sing too loud, as well as from various other causes, *indulge in the habit of what is called humming over their music. This*, if continued

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monics; and great difficulty is generally found in producing the higher harmonics, when the fundamental note is raised the slightest above its easy positions.

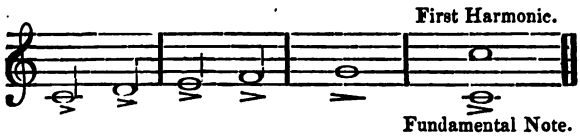
for any length of time, *is of itself enough to ruin any voice;* as the tones then produced are harmonics, which are moved below their natural pitch, by contracting the tube and diminishing the force of vibration. Consequently the lower notes, thus produced, are always uncertain and treacherous; for when we try to force their quality of tone, we are obliged to fly to the second point of production by more decided contractions of the glottis. The more we work at, or force, this kind of voice, the worse it becomes; for, as the nervous contraction of the glottis gains power, the purity and beauty of the musical voice become weakened; so that ultimately one of the most beautiful gifts of nature is utterly lost to us.

The facility with which we increase the power of the tones of the musical voice, in contradistinction to the sounds emanating from the glottis, as well as the manner in which we do so, is one of the best proofs of the existence of the two points of production, and also a sure means of ascertaining whether we are producing the pure quality of the musical voice or not.

Thus we increase the volume and power of the musical voice, by swelling the vibrations and allowing the whole of the tube to expand, which gives a sense of fulness to the throat; whereas all sounds formed by the glottis produce a feeling of *tightness* along the whole of the tube, and require strong *muscular force* to increase their tones.

The laws, and power of vibration requisite for the production and motion of the fundamental notes, when compared with those requisite for the production and motion of *the notes of their different scales*, will be found to be very simple; for nature intuitively dictates to us the force of vibration to be used *for the different qualities.* These laws will be perfectly comprehended from the following example:—Carry up the fundamental notes a fifth in any key or scale wherein the voice has freedom. (This must be done in the manner I have before mentioned for moving up the fundamental notes. And it will be found that, to regain the original fundamental note, the force of vibration must be diminished in exactly the same ratio as is requisite to take the first harmonic, which is

an octave above it. Thus:



This law will be understood to apply not to the *scale* of a *fundamental note*; for I have spoken throughout of a fundamental note and its *scale*, or quality, in a separate sense.

Various examples, &c. should be written to prove the powers and essential uses of these fundamental notes and their scales; the knowledge of which should be the great study of every singer; for they are the foundation or basis of the vocal instrument from which spring the whole of the upper tones of the voice (as I shall be able to prove in the article "Harmonics"); and consequently no person can sing with force and energy, or picture deep and impassioned feeling, without having practical knowledge, and a perfect command over them.

The more the glottis is contracted, the greater the difficulty which will be found in producing the fundamental notes and their scales; in consequence of the aperture not

being wide enough to allow the more sonorous vibrations to pass freely. Thus, an organ pipe, when too small in the bore, or, as it is technically termed, the "*voicing*," will yield its first harmonic, instead of its fundamental note; which accounts for the difference between the voice of youth and manhood; *for boys yield nothing but harmonics, until the aperture of the glottis expands.* This contraction of the tube, however, must not be taken as a law for the production of the harmonics; for the more openness we give to the vocal instrument, the richer become the quality and volume of its tones.

Thus it will be seen that the lower tones and pitch of the vocal instrument depend upon the formation of the trachea; while some persons (by nature, or steady and well-directed practice) have more facility than others in sustaining or changing the position of the trachea for the different fundamental notes of the voice.

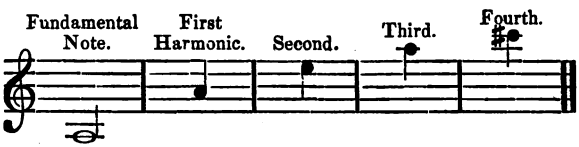
CHAP. III.

On the human voice producing harmonics, in the same manner as all musical wind instruments, which harmonics are dependant on the fundamental notes for their pitch, and have, according to their degree, scales, or a succession of notes ascending; which scales are governed by the free action of the diaphragm.

THE voice also agrees with all musical wind instruments, in having the power of producing various harmonics. I shall not enter into the theory of acoustics, but begin by stating the fact, that the harmonics of a note are, theoretically speaking, infinite. I shall classify these different sounds (as far as they ought to be used by the voice) in the same manner as the various writers on acoustics, namely: as the *first harmonic*, *second harmonic*, *&c.*

The *first* harmonic that a fundamental note will give is *its octave;* the *second* harmonic is a *twelfth from its fundamental note;* the *third* is *its second octave;* the *fourth* is a *major third above its second octave.*

Harmonics springing from a Fundamental Note of the Voice.



Each of these harmonics has its separate scale, leading to the next harmonic above it. They can be moved above and below their scales, only by moving the fundamental note with them, and by the same means as the fundamental note is moved, *namely, by increasing the vibrations, allowing the trachea to shorten itself in ascending, and diminishing the power of vibration, so that the trachea may fall in descending.*

The truth of this may be ascertained by attempting to regain the original fundamental note after moving either of the scales from their natural position. To prove this satisfactorily, first sing a fundamental note, then its different harmonics; and it will be found that we can return from even the highest harmonic to the fundamental note without the slightest alteration taking place in the tube; *the trachea, on the contrary, keeping*

one fixed position. This can be done (in the musical quality of tone) with the greatest ease. Breath may be taken between each note; but should we once move either of the scales of the harmonics, the fundamental note must be moved with it, and the key or pitch of the vocal instrument correspondingly changed. Thus each key or scale depends upon the fixed position of the trachea, and the power and the brilliancy of the voice upon the difference of the fundamental note being on the key note, or its dominant.

In using the phrase "*fixed position of the trachea*", it should *not* be understood *to refer to any tightness of the chest*, or a fixed sensation of the diaphragm; as upon the freedom of the diaphragm depends the different changes that take place in the vibrations of the column of air.

After carefully and practically investigating the powers of the musical voice in the production of the different scales, positive proof will be found that the whole of the upper part of the voice is entirely dependant upon a fundamental note formed by the fixed position of the trachea; *that the highest*

harmonic requires, to produce it, the same power of vibration as its fundamental note ;* and that (when these tones are properly produced) no alteration takes place in the tube from the motion of the larynx, &c.; for nature alone, from the free action of the diaphragm, causes the difference in the pitch of the sound, *by changing, as the harmonics ascend, the column of air into smaller vibrations.*

In regard to the alteration of the column of air, I am satisfied that the fundamental note and its scale are double and the harmonics single vibrations. For instance, should it require 250 *double* vibrations to produce the note C, we know well that it would take 500 double vibrations to produce the octave higher, as a fundamental note. But if we compress the same force of vibration into a *single* column, the quickness of the vibrations becomes *doubled*, and the octave higher

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* This I imagine to be correct in theory; but it is not so in practice; as it requires rather more force of breath for the firm production of the harmonics, as they ascend above their fundamental note: on account of the column of air being formed into such small vibrations, the breath is allowed to escape with greater freedom.

is produced as its first harmonic, while the higher harmonics, i. e. the second, third, &c. have the same force as the fundamental note, but compressed into smaller vibrations. The more minute study of this subject I leave to the experimental writers on acoustics.

I shall now proceed to consider the quality and powers of the different harmonics separately. The *first* harmonics that the fundamental notes of the voice produce, are open, clear, and powerful, and are called the smooth quality of the chest voice, by most musical and vocal writers. This mistake has arisen from the susceptibility of these harmonics to descend, parallel with the fundamental quality of the voice, even down to the gravest notes; but their power and brilliancy diminish when they are moved below their natural position in the voice.

A tetrachord, or fourth, is the compass of the scale of this first harmonic, which should not be moved above or below its natural pitch, unless the character or feeling of the music requires that particular style of expression. *For instance*, if we wish to produce a high note with great volume and power, we must carry

up this quality (as far as the trachea will allow) in the manner before mentioned; but it should always be borne in mind that in doing so we also move the fundamental notes; and consequently that, if we attempt to produce this quality of harmonic *above the power of the trachea, to form its fundamental note, or if, by contracting the tube at the glottis, we do not create a proper force of vibration within the tube, the trachea will instantly fall, and the voice break or crack into one of the higher harmonics belonging to one of the lowest fundamental notes of the voice.*

In carrying the first harmonics down in the lower part of the voice, we naturally render them weaker in quality; for the power of vibration must be diminished, in order to preserve the column of air in its single vibrated form: yet I have heard females produce, in this quality, tones as low as C below the line in the treble, and males down to the octave below. But I do not consider the cultivation of this first harmonic quality to such a depth in the voice to be a right course of study; for it deprives the pupil of the power to sustain the trachea in its higher

position, and so weakens the faculties and energies requisite to vibrate the fundamental notes and their scales.

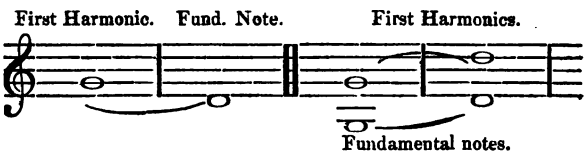
The power of producing harmonic tones thus low in the voice can be accounted for as follows. All harmonics being produced by a *single* vibrated column of air, the force of their vibrations may be diminished, so as to allow them to descend parallel with the *double* vibrated or fundamental quality of tone.

From the above it will be found, that we can produce harmonics much lower, though we cannot, by any possible means, produce them in the least degree higher, than their fundamental note.

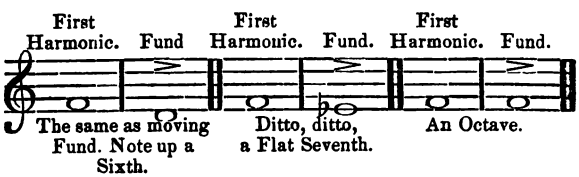
When using the first harmonic, we should always bear in mind that it is an octave above its fundamental note; and that if we wish to produce (on the same pitch) a fundamental note, after taking a first harmonic we must double the number of vibrations; for the producing such a note under such circumstances is exactly the same as moving the fundamental note an octave; the trachea taking a higher position, and a node of vibration being formed. We should also remember, that the

force of vibration and the force of breath are quite different in their results.

The following intervals, sung as I have marked them, will prove the foregoing theories.



To gain the fundamental note D after the first harmonic G, requires the same force of vibration as to move a fundamental note or its first harmonic up the interval of a fifth.



These examples refer only to the moving up of the fundamental note, starting from its first harmonic; for, from what I have before stated, it will be understood that we can move the first harmonic down parallel with its fundamental scale, by diminishing its vibrations.

Contraction of the glottis, or of any other

part of the vocal tube, produces on the harmonics the same bad effects as on the fundamental quality. Every precaution should be used to guard against this nervous contraction of the muscles; for by these means the first harmonic, which, for smoothness and tenderness of expression, is certainly the most beautiful part of the human voice, is often entirely excluded from the vocal organ.

The *second* harmonic is a fifth above the first harmonic, and a twelfth above its fundamental note. It has an open, clear quality in its easy scales, becomes more powerful as its fundamental notes are moved higher, and diminishes in power when descending below its natural position. It can be used low in the voice; but, then, of course, its quality is weak and uncertain. Still, numbers of persons, particularly ladies, sing entirely in this quality and the upper harmonics; and hence their voices are generally believed to be naturally weak. This opinion is, however, perfectly erroneous; for the natural powers of the voice may be recovered, as I myself have often proved in many cases, by proper and diligent practice. It is not, however, my in-

tention at present to treat of the practical study of singing, but rather to confine myself to the powers of the human voice, as developed by nature.

This second harmonic is known as the head voice of women, and the tenor voice of men. It can be moved above its scale by carrying its fundamental note up with it; but the greatest care and practice is required in order to be able to take the upper harmonics above their scales. For, these upper harmonics being so far removed from their fundamental note, we are too apt, in endeavouring to take them, to use contractions of the larynx and glottis, instead of following the laws I have before stated; and thus *the force of vibration becomes diminished, or cut off in the lower tube, whereupon the trachea immediately falls to its lowest position, and so produces an uncertain harmonic, or break, in the voice.*

The *third* and *fourth* harmonics of the voice are called the head clear quality in women, and the falsetto in men. It has been supposed by many that the falsetto notes of the voice were modified or formed in the

nasal tube; and they have consequently been called the head voice. This fallacy is easily disproved, by stopping the nostrils, when it will be found that a musical fundamental note and its harmonics can be produced quite as pure in tone as when the nostrils are perfectly free. Hence it appears that the nasal tube has nothing whatever to do in the production of the musical quality of the voice, though the column of air may be turned that way, either by certain modifications of the larynx and pharynx, or by closing any portion of the mouth when pronouncing the various consonants.

The third and fourth harmonics of the voice are of a brilliant quality of tone, when openly produced from the fundamental notes, and within the power of the trachea easily to sustain; but if we allow them to fall below the pitch whence we can produce their fundamental notes, they become uncertain, weak, and thin in quality.

The third harmonic is of the most consequence to singers. Being the second octave above its fundamental note, it can only rise one whole tone, in the same quality,

without carrying up its fundamental note with it. This, however, should never be done, except by very experienced singers; for, the foundation of the voice being disturbed, it becomes difficult to lower the position of the trachea, so as to regain, when descending the scale, the other harmonics belonging to its fundamental note; and if we are not able to accomplish this, the voice becomes weak, and all command over it is lost, in consequence of the force of the breath dissipating the column of air containing such small vibrations. In fact, we cannot move the same quality of tone without adhering to the laws of acoustics, which require us to increase the vibrations in ascending, and diminish them in descending. And it should be remembered that, in nature, the quality of tone changes with each different set of harmonics, every harmonic being dependant upon its fundamental note for its force of vibration; for we never could have possessed energy and power of vibration sufficient to form the higher tones of the vocal instrument, had not nature devised such means for their production.

In descending the scale from the higher harmonics, care must be taken not to check the power of vibration too much, but to keep the tube open, and give the diaphragm as much ease as possible, so that the column of air may change, on our regaining the upper notes of the scales of the different harmonics belonging to the fundamental note that we may be using.

From the above investigation of the nature of the different harmonics, when properly produced by the vocal tube, it results that the alteration of the fundamental note (by moving the trachea, or by contracting the larynx and glottis) gives rise to the several difficulties attendant upon the production of the higher sounds of the musical voice; that every person, unless prevented by mal-formation, which is seldom the case, *possesses the power to produce the different harmonics with the greatest ease;* and that the nervous uncertainty which is usually found to accompany the use of the upper tones of the voice, arises solely from the vocalist *striving against the laws of sound, and using art and force where there should be only natural freedom.*

CHAP. IV.

That there is no fixed break or sudden change in the quality or power of the voice, while moving it from its lowest to its highest tones; and that what are commonly known as breaks arise from the contraction of the larynx and glottis, which contraction takes from the diaphragm its free action, and so prevents the necessary changes in the column of air which are requisite for the production of the different notes or scales; also, that the tones of the voice are dependant on the action of the nervous system.

It is well known that many singers suffer from what is called a *break* in their voice; some vocalists have two, and I have known others with as many as three. Most persons consider this to arise from some natural defect, and, consequently, that it is not in the power of the singer, even by the greatest study and practice, wholly to overcome it. The notes upon which these breaks take place vary according to the style of the singer; for instance, we often hear a contr'alto produce splendid low tones in the fundamental quality of the voice; these tones are carried to the utmost limit that the tra-

chea will allow, and then the voice suddenly *breaks* into a weak kind of harmonic sound, over which the singer has little, if any, power. In others, this weakness of quality will be found in only three or four of their middle notes, after which the voice will again break into a more powerfully vibrated tone. In soprano singers, the *break* generally occurs higher in the voice, and then the notes above become hard and contracted, or weak and uncertain. In tenor singers, the *break* is well known to be between what is called *the chest voice* and the *falsetto.* The singers who have this break in the voice will name the very note on which it will take place, *for they have been practising for years to form the glottis into different positions at this particular note, in the vain hope of passing it smoothly.*

Now I assert that there is *no such thing as a break* in any person's voice *by nature*, but that it is caused by the nervous contraction of the larynx and glottis at a certain point of the scale, from the want of a practical knowledge of the fundamental notes and their harmonics.

In proof of this, suppose we sing a fun-

damental note, and, by increasing the vibrations with energy in ascending the scale, produce a succession of *fundamental notes:* it will be found that, as soon as the trachea has taken its highest position, it will be very difficult to sustain it there; and that, if we then use the slightest contraction at the glottis, the trachea will immediately *fall to its lowest position, and a break be formed,* by the voice producing an *harmonic* from a lower fundamental note; and that, if we employ more decided contractions of the glottis, the tones will become hard and unpleasant to the ear. A break thus formed in the voice becomes fixed upon one particular note; but upon what particular note it will occur, must depend upon the energy of the lungs in vibrating, and the power of the trachea in shortening the tube. The break once formed, however, great difficulty will be found in trying to remove it, *from the singer having been accustomed to use the fundamental notes without their proper scales.*

It will also be understood, by what I have before stated in regard to the tendency of the fundamental note to fix itself on the key-

note or its dominant, that, if we carry the fundamental scale, or any of its harmonics, but *one note beyond their natural limits*, the trachea will, directly freedom is given to it, fall *that one note*, and so occasion a slight break in the voice. Should we fancy this to arise from a defect in our vocal instrument, *nervous contraction will soon form it into a confirmed break* in that particular part of the voice.

Many persons produce the lower notes of the voice by contractions and modifications of the larynx and glottis. The tones thus produced, although very powerful, are always uncertain as regards intonation; they are also hard and reedy in quality; and, when the singer who produces his tones by these means is under the least excitement, and attempts to use either energy or force, his voice immediately becomes harsh and unpleasant. Now, supposing a lower note of the voice to be produced in this manner, and moved in the same quality of tone up the ascending scale (which is done by increasing the number of vibrations at the glottis), it will be found that, as these sounds rise in the scales,

they naturally become worse in tone, while the throat is so completely fatigued that the glottis partially opens; and the voice then passes into a very weak harmonic, belonging to the musical voice, and so gives rise to a break of the very worst description.

The *change*, which takes place in passing from the tones produced by the glottis, to the harmonics of the musical voice, is very sudden, and occasions a feeling like something giving way in the throat; for the tones of the glottis, being produced by contractions, are harsh and powerful; whereas the harmonics, from the want of openness and freedom in the tube at the layrnx and glottis, are weak and thin in quality. Consequently, when this kind of break is once formed, the upper notes, although they possess the musical quality of tone, must become (after practising any length of time on this principle) like a whistle or mere whisper, because there is an insufficient vent for the more sonorous vibrations in the tube.

Numbers of examples could be given as to the manner in which different kinds of breaks are produced; but, after a practical

investigation of the subject stated, it will be found that a break is formed in a voice *by working against the natural scales of the fundamental notes, and cultivating qualities of tone which are radically bad.* In fact, numbers of singers strive to form by force and art what nature by the most simple means produces perfect; for the musical voice, used with freedom in the first instance, must ultimately become pure and pleasing in the quality of its tone.

From the considerations contained in this paper, I deduce the following facts:—First, that there are two distinct points of production in the human voice:—Second, that the musical tones of the voice are produced by a *vibrated column of air formed in the trachea*, which column of air depends upon the openness of the glottis, and is *regulated by the free action of the diaphragm*:—Third, that the upper parts of the voice are *harmonic tones which spring from their fundamental notes*, and are dependant for their pitch on the length of the trachea:—Fourth, that what is called a break in the voice is not the result of a mal-formation, as is erroneously

supposed, but arises from the want of a proper knowledge concerning the management of the vocal instrument. There can be no doubt that the nervous system has the greatest power over the human voice; consequently, in cultivating the musical organ, we should be particular in guarding against the nervous contraction of the larynx and glottis.

The tendency of the laryngeal nerves slightly to collapse the cartilages of the larynx, when our feelings are depressed (at which time it is painful and difficult to sing), proves that the nervous temperament of the students should be studied, and every encouragement given to them, so that the tones may be vibrated openly from the chest, according to the laws and nature of the vocal instrument; for when a young singer feels any uncertainty in taking a note, and shrinks in the attempt, the throat immediately contracts itself, and so dividing the column of air within it, thereby cutting off all power of using the vibrations of the musical voice. I have known students, who, on being told simply that they sang sharp or flat, and being desired

to try a particular passage over again, grew worse in their intonation each time they repeated it; not from any defect of the ear (for they felt that they were out of tune), but from the want of a proper command over the vocal instrument. In fact, they lost all power over the voice, on the slightest check being given to the nervous system.

From what I have just stated, it must not be supposed that a nervous person will find more difficulty, than one of a firmer tempament, in the cultivation of the vocal organ; for I have generally found that the nervous student has turned out the best singer in the end. Contractions at the larynx and glottis may at first impede the production of the musical voice; but, when once the column of air which gives rise to it is properly set in motion, the nervous quality of the vibrations will not only give additional beauty and expression to the tones, but impart to them the character of the different passions and sentiments of our nature.

CHAP. V.

Concerning the manner of applying the foregoing theories in vocal tuition, and briefly explaining the laws, and mode of producing and cultivating the tones of the musical voice.

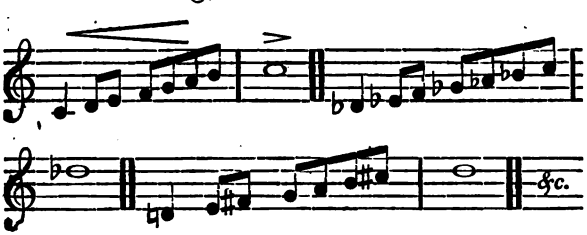
It is essentially requisite for every singing master to have a thorough knowledge of the different qualities of tone treated of in the preceding chapters, so as to be able to detect from which point of the vocal tube the various sounds of the voice are produced; for upon his judgment and direction depends the future excellence of the pupil.

I do not consider it necessary for every singer to study minutely the whole mechanism of the vocal tube; but the master should explain, as simply as possible, the two points at which sounds may be produced in the vocal instrument: for instance, the first point may be called the lungs; and the second point, the upper part of the throat (that part commonly termed *Adam's apple*). It may then be explained to the pupil, that from the lungs spring the vibrations that give rise to the

musical quality of tone, that all contractions at the throat stop the purity of those vibrations, and, consequently, that the proficiency of the singer depends upon the free action of the lungs, or, more properly speaking, of the diaphragm, that being the muscle acting upon them. Nor can the importance of acquiring this free action of the diaphragm be impressed too forcibly upon the student; for it is only when we gain a free command over that muscle, that our intonation reaches excellence, the tones of the voice becoming round, full, musical, and powerful, and the artiste feeling a certainty in the use of the voice, even while expressing the softer feelings, or the more violent passions of the mind. In fine, under such circumstances, singing is a pleasure, and attended with little, if any, fatigue to the vocalist. But if, on the other hand, we modify or contract the tube at the second point (the upper part of the throat), results the very reverse of the above are produced; our intonation becomes uncertain, the tones hard and unpleasant to the ear, and *a feeling of tightness is experienced at the chest; for, when the lungs have their free*

action, the throat cannot contract; and, vice versâ, when the throat becomes contracted, the lungs cannot have their free action.

When thus much of the nature of the vocal tube is perfectly understood by the pupil, he must be made acquainted with the power of vibration requisite for the production of the musical voice, from its lowest to its highest pitch. To accomplish this, the student must practise slowly the diatonic scales ascending, thus:



always bearing in mind the following rules. To respire with freedom, and then to allow the lungs to have entire command over the vibrated column of air formed in the tube, keeping the throat as open as when we take breath, and not permitting it to move in the least degree while the voice ascends the scale.

When the higher tones of the musical

voice are properly produced, a sensation of fulness will be experienced in the upper part of the tube. The pupil should also be careful to avoid employing any powerful or sudden impetus of the breath from the lungs, when first producing the tones, as the column of air is forced by these means out of the tube, instead of giving rise to the requisite vibrations within it; and he should, at the same time, allow the greatest possible freedom to the diaphragm, and permit the tube to expand as the energy of the vibration increases; each note thus produced must be independent of the other, that is to say, it must not be "lifted" by modification of the throat, nor forced up to the note above; for the column of air alone should be allowed to form the different notes by the simple action of the lungs.

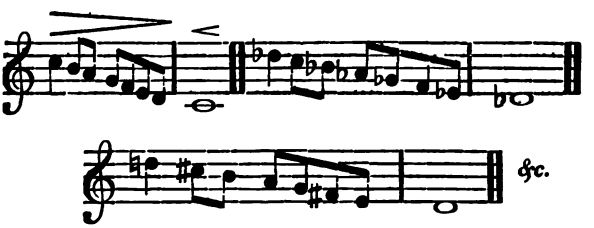
The richest and most powerful tones of the musical voice are produced with very little force or exhaustion of the breath; since the power of vibration, formed in the tube, prevents the breath escaping from the lungs. Upon the same principle, a great body of tone is produced by a good player in any

large wind instrument (like the ophycleide or trombone), with little, if any, more exhaustion of breath, than is required for the production of the softest note on the fife or flute. It ought, therefore, to be borne in mind, that every note, from the lowest to the highest in the compass of the voice, should be formed and increased by the nervous power of its vibrations (which give a sense of fulness to the tube), without exhausting the lungs, or straining the throat or the chest. If the student, while practising the ascending scales, feels a weakness come over the voice when producing the higher notes, he should be careful not to use force or contraction in attempting to regain the timbre or quality of tone, but follow strictly the principles I have laid down in the previous paragraph; for this feeling of weakness is caused by the column of air changing its vibrations on passing into the harmonics.

If a student has been long in the habit of using modifications and contractions of the throat in the production of the different notes, it will be very difficult for him to alter the point of production to that of the musi-

cal quality of tone: this, nevertheless, may be achieved by steady and well-directed practice.

When the voice can be used with openness and freedom in the ascending scales, the student should be made to practise the descending ones, thus:



To execute these scales properly, requires great study and exercise of the voice, together with a thorough practical knowledge of the laws by which the voice is naturally moved from the higher to the lower notes; whereas, a want of the knowledge requisite to regain the vibration or quality in descending passages, causes one of the greatest difficulties in the management of the vocal instrument. The singer who can at command regain the full vibrations when moving the voice to its lower tones, must, I am satisfied, be a good and experienced vocalist.

The following are the laws for producing the full quality of the voice in the descending scales:—*first*, the pitch or key in which we sing depends upon the length of the vocal tube (the trachea); that is to say, the shorter the tube, the higher the pitch:—*second*, the changes in the vibrations of the column of air which form the different intervals and scales, are caused by the action of the diaphragm; consequently, as the tones of the voice descend, the diaphragm should relax its power, so as to allow the column of air to diminish and elongate its vibrations; for if, on the contrary, the diaphragm be kept in a fixed position while the student is practising descending passages, the tones must become weaker and weaker, and the pupil lose all power over the voice; this arises (as I have proved in the previous chapter) from the voice producing a thin quality of harmonic, the diaphragm, when fixed, having no power to alter the vibrations of the column of air. The most simple mode of explaining the application of these laws to the pupils, is to desire them to slightly diminish the force of vibration while the voice descends the

scale, so as to *allow a sinking sensation to be experienced at the chest.*

These laws of the descending scale will be understood to apply to singing in general; for instance, the greater the interval we have to descend, the more the diaphragm must relax its power. And if, in any piece of music or melody, we have to move the voice down even a semitone, these laws must be applied in the production of the tone; for should we fail to do so, we must instantly lose that firm command over the vocal instrument which is so essentially necessary to every vocalist. Nervous action has considerable power over the great muscle of the chest, giving it a fixed or tight sensation, and so producing a collapsed feeling of the lungs; consequently, the sinking at the chest above mentioned cannot in any way be forced by the singer, but should, on the contrary, be encouraged by the most gentle means, so as to allow the lungs to have a kind of floating or buoyant sensation.

It is generally supposed that it requires great force and exertion of the lungs and muscles of the throat to produce the higher notes of the voice with fulness and power;

in fact, numbers of singers do so by such means. The adoption of this course is not only a sure mode of destroying the beauty of the vocal organ, but it naturally conveys a feeling of uncertainty to the listeners, who cannot hear the vocalist with any degree of pleasure, from a fear that, when taking a high note, his voice will crack or give way; for when a singer strains and uses force in the production of his tones, we intuitively feel that he is not following the laws of nature. In proof of this statement, let the reader sing a note, pitched high in the voice, upon the following principles. Having freely taken breath, let him keep the tube as open as possible at the glottis, and then in vibrating the note from the lungs take care not to give the slightest force or jerk to the breath, but to allow the column of air to vibrate *in the tube;* for if the slightest force or jerk be given before the column of air is set in motion, the vibrations will be forced out of the tube, and the breath escape. It should be remembered, that the higher notes of the voice are of a more delicate nature than the lower and more sonorous tones; consequently, when we

attempt to produce the former by force, the glottis immediately will contract itself, in order to stop the breath or vibrations from escaping too quickly from the tube, and a hard quality of sound belonging to the second point (or speaking voice) be produced, or else the voice will entirely give way.

Even in the first production of the lower or more sonorous tones of the voice, care must be taken not to force or jerk the breath; and, although I have used the phrase "slight impetus of the lungs" in a previous chapter, the greatest caution must be used by the young singers against applying it in the first production of the tone; for, unless the vocalist has full command over the muscles of the larynx, so as to keep the glottis and the whole of the tube perfectly open, the vibrations will be forced out of the tube before the voice becomes properly formed. It will, however, be understood, that, when once the vibrations of the musical voice are properly produced, its tones may be increased in volume and power, in the manner before stated, namely, by allowing the tube to expand, and giving nervous energy to the vibrating column.

In passing the voice from a low to a high note, no force must be used, nor should a sense of lifting up the quality of the tone be experienced. For the lower tones, being formed in the tube by a double vibrated column of air, are naturally of a more heavy and sonorous quality; consequently, the force requisite to sustain them must be diminished or weakened for an instant, when the voice is about to be raised, in order that the necessary alterations in the formation of the vibrating column producing the upper note may be effected without the muscular action of the larynx, or modification of any other portion of the vocal organ. This weakening the force of the vibrations of the lower note should take place but for a moment previous to the raising the voice, while, immediately upon raising it, the organ should again have the free action of the diaphragm and openness of the tube, without any sudden impetus from the lungs, or the application of any more force than was requisite for the production of the lower note.

The higher tones of the voice, when produced properly, according to the preceding

directions, will always be found full and powerful; whereas those produced by "force" and "lifting up" will not be so fine in quality or tone; nor will the voice, under the latter circumstances, be sustained with ease, but, on the contrary, the endeavouring to do so will occasion a sense of fatigue to the singer, from the trachea being thus lifted into too high a position.

It must be distinctly understood that the throat has nothing to do in the alteration of the ascending or descending notes, when the tones are produced naturally; but that the different scales and intervals are formed by the free action of the diaphragm on the column of air; and if we have recourse to any modification or contraction in the throat, our intonation will become uncertain, and we shall ultimately lose all power over the musical quality of tone.

I shall not go into the more minute details of vocal tuition in this treatise, as that branch of the subject I consider more suited to an elementary work on singing; this I hope to bring before the musical world at some future period: but, in conclusion, I beg to guard the

young singer against straining or forcing the voice in any way, as well as attempting to practise when suffering under cold, or the slightest inflammation of the air tubes; as, under these circumstances, the trachea loses its power of reflecting the vibrations, or, in other words, the sounding-board of the instrument becomes muffled, and we are then apt to have recourse to contractions of the throat in the production of the tones. In practising the voice, its beauty and purity must be the first consideration; and it should always be borne in mind, that it is quality of tone which distinguishes a singer, not flexibility or compass; the latter, added to the former, however, are undoubtedly most essential, and, when combined by a mind capable of portraying the various passions of our nature, must tend to bring the vocalist as near to perfection as possible.

An article has appeared in a non-medical journal in opposition to that portion of the preceding paper which was published in the Lancet. As the controversy may possess some interest for the physioligist, and tend to throw additional light on this portion of the subject, I quote the objections of the writer, with my answer appended thereto. The paragraphs are numbered, for the sake of reference.

No. 1. "All voice proceeds from laryngeal power and its attending machinery. The larynx is a seraphine reed, and possesses muscles, which expand or contract. They act upon the *chordæ vocales* of the glottis, which may thus, like strings, be drawn up or let down at the will of the singer or speaker. Tie up or divide the nerves of these muscles, and the power to sing or to speak is gone."

This paragraph contains *two distinct theories* for the production of tone by the glottis—first, as a seraphine *reed;* second, by muscular tension, like *strings*, &c. Now I agree that the glottis produces its tones upon the principle of a membranous tongue or *reed;* but the theory of comparing it to a *string* has long since been exploded (and how such an idea could ever have been received is to me most unaccountable); for most persons are aware that a string depends upon its *length* as well as its *tension* in the production of its tones; consequently, it cannot bear the slightest analogy to the *chordæ vocales*. As regards the assertion, "Tie up or divide the nerves," &c. it is no proof against the musical voice being formed by *a column of air;* because, should we sever either of the laryngeal nerves, the cartilages of the larynx belonging to that nerve would immediately collapse, or be sucked in, by which means the vent for the vibrating column would be stopped. The writer then proceeds to say:—

No. 2. "We have had many experiments with the human larynx, and, in a recent case, the larynx was that of a

very fine young woman who had destroyed herself, and was as perfect and fresh as that of a living being. The trachea was cut off almost altogether so, and a common bellows applied to the small remains of the tube. There was no lower point of production remaining. The application of the current of air produced the full, fine-bodied quality of a contralto voice of a very considerable extent in gamut."

This statement to a certain extent is true. But in this experiment on a *dead* larynx, where is the "laryngeal power," *muscular tension*, "*like strings*," &c. from which (paragraph, No. 1) the voice is said to proceed? A succession of tones may have been produced, as stated in the above experiment, upon the system of a membranous tongue or reed; but then the sounds must have partaken of that quality; and on the *quality* of tone thus produced depends the point to be proved. It will be allowed that the researches and experiments of M. Savart on this portion of the subject have been careful and elaborate in the extreme. He tested the powers of the dead larynx in every possible manner, and what were the results? Why, Savart says that the tones thus produced were not to be compared with the beauty of the musical tones of the voice, but were *harsh and discordant*. And there is no doubt that he is right; for the speaking voice is (in common conversation) produced by the glottis, which accounts for its having that close reedy quality, in contradistinction to the pure *open tone* of the musical voice. Numbers of proofs could be given of this decided change in the tone. For instance, go to a cathedral, and listen to the great difference in the quality of tone when the choir change the responses from speaking to singing. Again, a person who stutters is able to sing, and, at the same time, pronounce fluently. In accounting for this, the different writers say the glottis is open when producing the singing voice. This at once proves a different point of production for musical sounds; for, the glottis being a membranous tongue or *reed*, all its different tones *must* be produced by the approximation of the *chordæ vocales*.

GLOSSARY*.

ANATOMY.

Bronchial tubes. A number of very small tubes or vessels which convey the air into the lungs.

Bronchi. Two tubes which connect the *trachea* with the *lungs*.

Cartilages of the larynx. The inner substances of the larynx.

Chordæ vocales. The tendons, or rim of the glottis, sometimes called the lips of the glottis.

Diaphragm. A very large convex muscle, which has full power over respiration; it is seated below the lungs, and divides the chest from the abdomen.

Epiglottis. A fleshy substance which covers the opening of the larynx during the time of swallowing.

Glottis. The *mouth* or *opening* in the larynx; it has the power of expanding or contracting by means of the different muscles of the larynx.

Larynx. The larynx is that portion of the air tube just above the *trachea;* its position can be seen by a projection in the throat, which is commonly called *Adam's apple.* It is formed of different cartilages and muscles folding one

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* For a further and proper knowledge of the following terms, the reader must peruse works on the sciences to which they refer.

over the other, which have the power of expanding or contracting the glottis.

Lungs. The organs of respiration; they are spongy substances, seated on each side of the chest.

Laryngeal nerves. These nerves are branches from the *Par vagum nerve* which springs from the nervous centre (the brain); they give sensation and motion to the muscles of the *layrnx, trachea, &c.*

Palatine arches. Thin membranes, like threads, springing from the uvula, form the rim of the palatine arches, which arches are seated at the back part of the mouth, and may be plainly seen when it is wide open.

Par vagum. A nerve, which arises from the brain; it is called the pneumo-gastric nerve, and gives off several branches, among which are the pharyngeal, the superior laryngeal, the recurrent or inferior laryngeal, and the bronchial branches; it has also a close communication by means of its branches with the glosso-pharyngeal, lingual, and sympathetic nerves; consequently, it is the principal nervous power acting on the vocal organ.

Pharynx. A cavity situated above the larynx, communicating with the nasal passages; it may be partially seen by opening the mouth and lowering the tongue.

Stethoscope. A tube made of wood, used by the faculty in cases of consumption, for hearing the different sounds or murmurs of the lungs.

Trachea. A tube commonly called the wind-pipe, through which the air passes to and from the lungs; it is formed of cartilaginous rings, by which means it is elongated or shortened.

Uvula. The uvula may be seen when the mouth is opened; it is a small fleshy elongation or tongue, seated at the back part of the palate, or roof of the mouth.

ACOUSTIC.

Column of air. This term implies a column of air in a state of vibration, the same as may be created in a flute or horn. (For its formation, see the article pipe, harmonic, &c. in acoustics).

Fundamental note. The lowest note that a pipe or tube will produce.

Hurmonics. Different sounds produced from the same length of tube as their fundamental note.

Node. A point formed in the middle of a tube when in a state of vibration, caused by the condensations and rarefactions of the air.

Point of production. That point of the tube where the first vibrations are formed.

Reed. A point producing the first vibrations by the approximation of its parts, as the mouth-piece of an oboe or clarinet.

MUSIC.

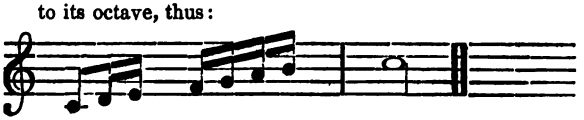
Dominant. The fifth note of the simple (or diatonic) scale.

Key note. The note which regulates the pitch of a song or piece of music.

Major third. The third note of the diatonic scale.

Octave. The eighth note higher or lower.

Scale. The diatonic is the only scale referred to in this work. It is a succession of eight notes, leading from a key note to its octave, thus:



(For its formation, see Pianoforte Primer).

Tetrachord. A scale of four notes; it is exactly the half of the diatonic scale.

FINIS.

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